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Development of a methodology for extreme flood estimation

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1. Introduction

The development of a methodology for **extreme flood** estimation is the aim of the project CRUEX++. This project follows the CRUEX project which aimed at the development of a PMP-PMF methodology (PMP=Probable Maximum precipitation, PMF=Probable Maximum Flood). Numerous tools, models and methods have been developed during the last years. The goal of the CRUEX++ project is to combine and enrich these elements leading to a methodology for extreme flood estimations in order to verify dam safety. A PhD thesis has been initiated in 2012 to lead this project and to conclude on a final methodology.

2. Approaches

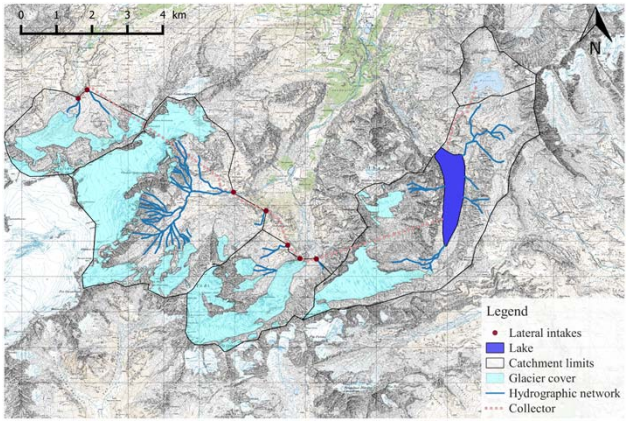
The 2 main families of approaches taken into account are the statistically based methods and the simulation based methods.

In the context of the **statistically based methods**, the theory of extremes, englobing the General Extreme Value Distribution (GEV) and the Peak Over Threshold Method (POT), as well upper bounded statistical distributions are included.

In the domain of the **simulation based methods**, the semi-distributed conceptual hydrological model GSM-Socont is used. This model allows Precipitation-Discharge simulations, respecting the contributions of snow fall, surface runoff, infiltration as well as snow and glacier melt.

The **PMP-PMF approach** based on the Swiss PMP maps, elaborated during the CRUEX project is also considered and allows the estimation of the upper bound for the upper bounded statistical distributions.

3. Case study of Limmernboden

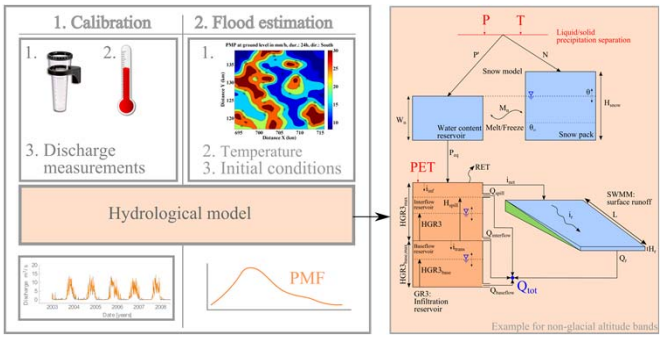


- Northern Swiss Alps
- Area: 17.8 km^2
- 7 lateral intakes
- Additional catchment: 31.8 km^2
- Total glacier cover: 17.5 km^2
- Altitude range: 1870-3614 m a.s.l.
- Karstic behaviour

- A detailed description of the case study has been presented at IUGG 2015 and can be consulted by scanning the following QR code

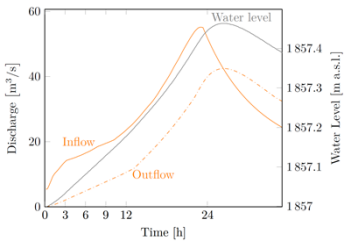
- 2 approaches are applied
  1. Statistically based methods
  2. Simulation based PMP-PMF method
- The results are combined through the upper bounded distribution LN4.

4. PMP-PMF simulation approach

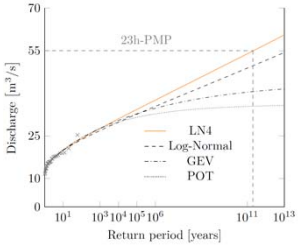


5. Results and discussion

- The critical water level in the lake was reached for a 23h-PMP



- Statistical extrapolations using GEV, POT and Gradex



- Comparison between the PMF and the statistical estimation of the safety flood by 1.5Q$_{1000}$ by ratio R defined by $R = \frac{Q_{PMF}}{1.5Q_{1000}}$
- 1.5Q$_{1000}$ is admitted in the Swiss dam safety guidelines as safety flood In this case, there is generally a good agreement among the statistical extrapolations for the estimation of Q$_{1000}$.
- The estimation retained for the comparison is Q$_{1000}$=27 m^3/s.
- The value of R=1.36 indicates that the critical safety flood estimated with the PMP-PMF approach is 36% higher than the statistical approach proposed by OFEN (2008).
- The PMF estimation can be considered reasonable.

6. Conclusions

- The case study of the Limmernboden dam has been used to illustrate the application of the PMP-PMF approach for a Swiss alpine catchment.
- The extrapolations show that the LN4 distribution estimates tend to be larger than conventional statistical distributions.
- This is due to the consideration of the PMF for the extrapolation.
- The extrapolations using conventional statistical distributions only consider what has been measured. If large floods have not been observed, the estimations would probably be underestimated.

Acknowledgements
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